Reg. No. :

Question Paper Code : 71449

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Electronics and Communication Engineering

EC 2253/EC 43/EC 1253/080290021/10144 EC 404 — ELECTROMAGNETIC FIELDS

(Regulation 2008/2010)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Stokes theorem.
2. What is the relationship between electric scalar potential and electric field intensity?
3. What is magnetic vector potential?
4. State Lorentz force equation for a moving charge.
5. State Poisson's and Laplace's equations.
6. What is mutual inductance?
7. What is displacement current?
8. Define Poynting Vector.
9. What is skin effect?
10. What is Brewster angle?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A charge $Q_1 = 3 \times 10^{-4}$ C is at a point M(1,2,4) and a second charge $Q_2 = -10^{-4}$ C located at a point N(2,0,10) in vacuum. Find the force exerted on Q_2 by Q_1. (4)

(ii) Infinite uniform line charges of 5 nC/m lie along the x and y axes in free space. Find E at P_A (0, 0, 4) and at P_B(0, 3, 4). (4)

(iii) Derive an expression for Electric field on the axis of a uniformly charged circular disc. (8)

Or

(b) (i) Define divergence and curl. (4)

(ii) Derive an expression for potential due to electric dipole. (6)

(iii) State Gauss law and prove it. (6)

12. (a) (i) Find H in rectangular co-ordinates at P(2,3,4) if there is a current filament on the z axis carrying 8 mA in the a_z direction. (4)

(ii) Express Biot-Savart Law in vector form and describe it. (4)

(iii) State Ampere's circuital law and discuss about any two simple applications of it. (8)

Or

(b) (i) Derive an expression for Torque on a loop carrying a current I. (12)

(ii) Define magnetic flux density and magnetic moment. (4)

13. (a) (i) Derive the boundary conditions for electric fields. (8)

(ii) Derive the expressions for electrostatic energy and energy density. (8)

Or

(b) (i) State continuity equation for current and point form of ohm's law.(4)

(ii) Discuss in detail the nature of magnetic materials. (6)

(iii) A solenoid is 50cm long, 2 cm in diameter and contains 1500 turns. The cylindrical core has a diameter of 2 cm and a relative permeability of 75.This coil is coaxial with a second solenoid 50cm long, 3 cm in diameter and having 1200 turns. Calculate the inductance for the inner solenoid; find inductance of the outer solenoid; determine mutual inductance between the two solenoids. (6)

14. (a) (i) From basic principles, derive Maxwell's four equations in integral form and differential form. (12)

(ii) State the modified form of Ampere's circuital law. Why was it modified? Justify. (4)

Or

(b) (i) Derive expressions for Instantaneous, Average and Complex Poynting Vector. (12)

(ii) Interpret $E \times H$. (4)

15. (a) (i) Derive Wave equation from Maxwell's equations. (6)

(ii) What is a Uniform Plane Wave? Derive the relation between E and H in a Uniform Plane Wave. (10)

Or

(b) (i) Discuss in detail with relevant expressions and figures, the concepts involved in reflection of plane waves by a perfect conductor at normal incidence. (10)

(ii) A uniform plane electromagnetic wave is inddent normally upon a sheet of dielectric material, which has the following constants: $\varepsilon = 4\varepsilon_0, \mu = \mu_0, \sigma = 0$. If the sheet is 2cm thick and the amplitude of the electric field strength of the incident wave is 100mv/m, determine the electric field strength of the wave after passing through the sheet, if the frequency is 3000 MHz; if the frequency is 30 Hz. Comment on the results. (6)

Reg. No. :

Question Paper Code : 51400

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fourth Semester

Electronics and Communication Engineering

EC 2253/EC 43/EC 1253/080290021/10144 EC 404 — ELECTROMAGNETIC FIELDS

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. In XY plane, $Q_1 = 100\ \mu C$ at (2,3)m experiences a repulsive force of 7.5N because of Q_2 at (10.6)m. Find Q_2.

2. What is Gradient.

3. If the magnetic field $B = 25x\vec{i} + 12y\vec{j} + \alpha z\vec{k}$ (T), find α.

4. Write Biot-Savart law.

5. An infinite solenoid (n turns per unit length, current I) is filled with a linear material of susceptibility χ_m. Find the magnetic field inside the solenoid.

6. Write the boundary conditions for electric field.

7. Find the Poynting vector on the surface of a long straight conducting wire (of radius 'b' and conductivity σ) that carries a direct current I.

8. State the flux rule for a nonrectangular loop moving through a nonuniform magnetic field.

9. A sinusoidal electric intensity of amplitude 250 V/m and frequency 1 GHz exists in a lossy dielectric medium that has a relative permittivity of 2.5 and loss tangent of 0.001. Find the effective conductivity of the lossy medium.

10. What is skin depth?

PART B — (5 × 16 = 80 marks)

11. (a) (i) State and Explain the fundamental theorems of Divergence and Curl. (8)

(ii) Find the electric field at a distance 'z' above the center of a flat circular disc of radius R, which carries a uniform surface charge σ. (8)

Or

(b) (i) Get the relationship between potential and electric filed. A (physical) dipole consists of two equal and opposite charges separated by a distance d. Find the approximate potential at points far from the dipole. (6)

(ii) Find the electric field at a distance 'z' above the center of a circular loop of radius r, which carries a uniform line charge λ. (5)

(iii) Given below the electric field variation find the odd one out.

(1) $\mathbf{E} = c\left[xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}\right]$

(2) $\mathbf{E} = c\left[y^2\hat{i} + (2xy + z^2)\hat{j} + 2yz\hat{k}\right]$.

Find the potential for the possible filed, using the origin as your reference point. (5)

12. (a) (i) Find the magnetic field at the centre of a square loop, which carries a steady current I. Let R be the distance from centre to side. Find the field at the centre of a n-sided polygon, carrying a steady current I. Again, let R be the distance from the centre to any side. Find the formula in the limit n (number of sides) tends to infinity. (8)

(ii) Find the magnetic field a distance h above the center of a circular loop of radius R, which carries a steady current I. (8)

Or

(b) (i) Derive the Ampere's law. (8)

(ii) Derive the expressions which mutually relate Current density **J**, Magnetic field **B** and Magnetic vector potential **A**. (8)

13. (a) (i) Derive the expression for the energy of a point charge distribution. Three point charges –1 nC, 4 nC, and 3 nC are located at (0, 0, 0), (0, 0, 1) and (1, 0, 0) respectively. Find the energy in the system. (8)

(ii) A small loop of wire (radius a) lies a distance z above the center of a large loop (radius b). The planes of the two loops are parallel, and perpendicular to the common axis. Suppose current I flows in the big loop. Find the flux through the little loop. Find the mutual inductance. (8)

Or

(b) (i) Write the Poisson's and Laplace's equations. (4)

(ii) Discuss the magnetic boundary conditions. (6)

(iii) Two concentric metal spherical shells of radii a and b are separated by weakly conducting material of conductivity σ. If they are maintained at a potential difference V, what current flows from one to the other? What is the resistance between the shells? Find the resistance if b >> a. (6)

14. (a) (i) Explain Ampere's circuit law. (8)

(ii) Derive Poynting's Theorem. (8)

Or

(b) (i) Describe the Maxwell's equations in differential and Integral forms. (8)

(ii) Write Faraday's law in differential and integral forms and explain Faraday's experiments. (8)

15. (a) (i) Derive the wave equations for Electric and Magnetic fields. (8)

(ii) The electric field intensity of a linearly polarized uniform plane wave propagating in the +z direction in seawater is $\vec{E} = 100\cos(10^7 \pi t)\vec{i}\ \ V/m$ at z = 0. The constitutive parameters of seawater are $\varepsilon_r = 72$, $\mu_r = 1$, and conductivity $\sigma = 4\ S/m$. Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength and skin depth. Also find the distance at which the amplitude of E is 1% of its value at z = 0. (8)

Or

(b) (i) Analyze the wave behaviour at boundaries under oblique incidence and derive the Brewster's angle. (12)

(ii) Prove that a linearly polarized wave can be resolved into a right hand circularly polarized wave and a left hand circularly polarized wave of equal amplitude. (4)

Reg. No. :

Question Paper Code : 91402

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Fourth Semester

Electronics and Communication Engineering

EC 2253/ EC 43/EC 1253/ 080290021/ 10144 EC 404 — ELECTROMAGNETIC FIELDS

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Stokes theorem and give its meaning.

2. A 15 nC point charge is at the origin in free space. Calculate V_1 if point P_1 is located at $P_1(-2,3,-1)$ and V = 0 at (6,5,4).

3. A current filament carrying 15 A in the a_z direction lies along the entire z axis. Find H in rectangular coordinates at $P_A(2,-4,4)$.

4. What is Magnetic vector potential?

5. State point form of Ohm's law.

6. Find the magnetization in a magnetic material where $\mu = 1.8 \times 10^{-5}$ H/m and H=120 A/m.

7. State Poynting vector.

8. Maxwell's Second Equation is based on a famous law. What is it? Substantiate.

9. What is Uniform Plane Wave?

10. Define Brewster angle.

PART B — (5 × 16 = 80 marks)

11. (a) (i) State Gauss law and explain its applications. (6)

(ii) Three infinite uniform sheets of charge are located in free space as follows: 3 nC/m² at z = −4, 6 nC/m² at z = 1 and −8 nC/m² at z = 4. Find E at the points P_A(2,5,−5), P_B(4,2,−3), P_C(−1,−5,2) and P_D(−2,4,5). (6)

(iii) Point charges of 50 nC each are located at A(1,0,0), B(−1,0,0), C(0,1,0) and D(0,−1,0) in free space. Find the total force on the charge at A. (4)

Or

(b) (i) Define Curl, Divergence and Gradient and state their meanings. (6)

(ii) Find the potential due to an electric dipole. (6)

(iii) Two uniform line charges, 8 nC/m each, are located at $x = 1$, $z = 2$ and at $x = -1$, $y = 2$ in free space. If the potential at the origin is 100 V, find V at P(4,1,3). (4)

12. (a) (i) Find H in rectangular components at P(2,3,4) if there is a current filament on the z axis carrying 8 mA in the a_z direction. Repeat if the filament is located at $x = -1$ and $y = 2$. Find H if both filaments are present. (6)

(ii) State Ampere's Circuital law and explain its applications. (6)

(iii) A filamentary conductor is formed into an equilateral triangle with sides of length l carrying current I. Find the magnetic field intensity at the center of the triangle. (4)

Or

(b) (i) State Lorentz force equation for a moving charge and explain its applications. (6)

(ii) Derive the expression for Torque on a loop carrying a current I. (10)

13. (a) (i) State and prove the boundary conditions for static magnetic field and static electric field. (10)

(ii) Derive the expression for electrostatic energy density. (6)

Or

(b) (i) Derive the Capacitance of a parallel plate capacitor. (4)

(ii) Calculate the self-inductances of and the mutual inductances between two coaxial solenoids R_1 and R_2, $R_2 > R_1$, carrying currents I_1 and I_2 with n_1 and n_2 turns/m respectively. (6)

(iii) Derive the expression for energy density in magnetic fields. (6)

14. (a) (i) Derive Maxwell's equations from basic principles. (10)

(ii) Derive the expression for power flow in a co-axial cable. (6)

Or

(b) (i) Derive the expression for Poynting vector. (10)

(ii) Why is Ampere's circuital law modified? How is it modified? Substantiate. (6)

15. (a) (i) Derive Wave Equation from Maxwell's Equations. (8)

(ii) Describe the concept of Plane Wave propagation in good conductors. (8)

Or

(b) Explain with relevant expressions, the concept of reflection of plane waves by a perfect dielectric at both normal and oblique incidence.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 11328

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fourth Semester

Electronics and Communication Engineering

EC 2253/147403/EC 43/10144 EC 404/EC 1253/080290021 – ELECTROMAGNETIC FIELDS

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Divergence theorem.
2. What is the significance of electric flux density?
3. Write Lorentz's force equation for a moving charge.
4. Define the term 'Magnetic flux density'.
5. What do you understand from current continuity equation?
6. Define the term 'Relative permeability'.
7. Define Faraday's law of Electromagnetic induction.
8. An EM wave has E_x and H_y as components of electric and magnetic fields respectively. Find the direction of power flow.
9. What do you mean by a wave?
10. An EM wave has electric component given by, $\vec{E} = E_0 \sin(\omega t - \beta z)\left(\vec{a}_x + \vec{a}_y\right)$ V/m. Comment on the polarization of the wave.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Find the electric field intensity at a point P located at (0,0,h) m due to charge of surface charge density σ C/m² uniformly distributed over the circular disc $r \le a, z = 0m$. (10)

(ii) Determine the divergence and curl of the given field $F = 30_{ax} + 2xya_y + 5xz^2a_z$ at (1,1, – 0.2) and hence state the nature of the field. (6)

Or

(b) (i) Point charges Q and –Q are located at $(0,0,d/2)$ and $(0,0,-d/2)$. Show that the potential at a point (r,θ,ϕ) is inversely proportional to r^2 noting that $r >> d$. (8)

(ii) Given a field $E = \frac{-6y}{x^2}a_x + \frac{6}{x}a_y + 5a_z$ V/m, find the potential difference V_{AB} between A(–7,2,1) and B(4,1,2). (8)

12. (a) (i) Derive an expression for magnetic field intensity due to a linear conductor of infinite length carrying current I at a distant point P. Assume R to be the distance between conductor and point P. Use Biot Savart's law. (8)

(ii) Derive an expression for magnetic field intensity on the axis of a circular loop of radius '*a*' carrying current I. (8)

Or

(b) (i) Obtain the expressions for scalar and vector magnetic potential. (8)

(ii) At a point $P(x,y,z)$ the components of vector magnetic potential $\overline{A}$ are given as $A_x = 4x + 3y + 2z$, $A_y = 5x + 6y + 3z$ and $A_z = 2x + 3y + 5z$. Determine the magnetic flux density $\vec{B}$ at the point P. (4)

(iii) Given the magnetic flux density $\overline{B} = 2.5\left(\sin\frac{\pi x}{2}\right)e^{-2y}\overline{a_z} Wb/m^2$, find the total magnetic flux crossing the strip defined by $z = 0$, $y \geq 0$, $0 \leq x \leq 2m$. (4)

13. (a) (i) Determine whether or not the following potential fields satisfy the Laplace's equation.

(1) $V = x^2 - y^2 + z^2$ (2)

(2) $V = r\cos\varphi + z$ (3)

(3) $V = r\cos\theta + \varphi$. (3)

(ii) Solve the Laplace's equation for the potential field in the homogenous region between the two concentric conducting spheres with radius '*a*' and '*b*' where $b > a$, $V = 0$ and $r = b$ and $V = V_0$ at $r = a$. Find the capacitance between the two concentric spheres. (8)

Or

(b) (i) Derive the expression for the inductance of a toroidal coil with N turns, carrying current I and the radius of the toroid R. (8)

(ii) Considering a toroidal coil, derive an expression for energy density. (8)

14. (a) (i) Electric flux density in a charge free region is given by $\overline{D} = 10x\hat{a}_x + 5y\hat{a}_y + kz^2\hat{a}_z \mu C/m^2$, find the constant k. (6)

(ii) If electric field intensity in free space is given by $\overline{E} = \frac{50}{\rho}\cos(10^8 t - 10z)\hat{a}_\rho V/m$. Find the magnetic field intensity $\overline{H}$. (10)

Or

(b) (i) State and prove Poynting theorem. (8)

(ii) Derive the expression for total power flow in co-axial cable. (8)

15. (a) (i) From the Maxwell's equation, derive the electromagnetic wave equation in conducting medium for E and H fields. (10)

(ii) Calculate the attenuation constant and phase constant for the uniform plane wave with the frequency of 100 GHz in a conducting medium for which $\mu_r = 1$ and $\sigma = 58 \times 10^6$ S/m. (6)

Or

(b) (i) With reference electro magnetic waves, explain the following:

(1) linear polarization (3)

(2) circular polarization (3)

(3) elliptical polarization (2)

(ii) A plane wave is incident, normally on a perfect conductor.Derive the expression for standing wave. Find the location of nodes and antinodes in E and H fields. Sketch the Standing wave pattern. (8)

Reg. No. :

Question Paper Code : 21358

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fourth Semester

Electronics and Communication Engineering

EC 2253/EC 43/10144 EC 404/EC 1253/080290021 — ELECTROMAGNETIC FIELDS

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define electric field and electric potential.

2. State divergence theorem.

3. State Biot-Savarts law.

4. Define magnetic vector potential.

5. Determine the capacitance of the parallel plate capacitor composed of tin foil sheets, 25cm square for plates separated through a glass dielectric 0.5cm thick with relative permittivity of 6.

6. State point form of Ohm's law.

7. Distinguish between conduction current and displacement current.

8. Write down the expressions for instantaneous and complex Poynting vector.

9. Find the skin depth at a frequency of 3MHZ is aluminium where $\sigma = 38.2 M\ s/m$ and $\mu_r = 1$.

10. What is Brewster angle?

PART B — (5 × 16 = 80 marks)

11. (a) Derive an expression for the electric field due to a straight and infinite uniformly charged wire of length 'L' meters and with a charge density of $+\rho c/m$ at a point P which lies along the perpendicular bisector of wire. (16)

Or

(b) (i) A uniform line charge $\rho_L = 25 Nc/m$ lies on the x = 3m and y = 4m in free space. Find the electric field intensity at a point (2, 3 and 15) m. (8)

(ii) Given that potential $V = 10 \sin\theta \cos\Phi / r^2$ find the electric flux density D at $(2, \pi/2, 0)$. (8)

12. (a) (i) Derive an expression for force between two current carrying conductors. (8)

(ii) An iron ring with a cross sectional area of 3 cm square and mean circumference of 15cm is wound with 250 turns wire carrying a current of 0.3A. The relative permeability of ring is 1500. Calculate the flux established in the ring. (8)

Or

(b) Derive the expressions for magnetic field intensity and magnetic flux density due to finite and infinite line carrying a current 1. (16)

13. (a) Derive the boundary conditions of the normal and tangential components of electric field at the interface of two media with different dielectrics. (16)

Or

(b) The capacitance of the conductor formed by the two parallel metals sheets, each 100cm², in area separated by a dielectric 2 mm thick is 2×10^{-10} micro farad. A potential of 20kv is applied to it . Find

(i) Electric flux (4)

(ii) Potential gradient in kV/m (4)

(iii) The relative permittivity of materials (4)

(iv) Electric flux density. (4)

14. (a) With necessary explanation, derive the Maxwell's equation in differential and integral forms. (16)

Or

(b) (i) The conduction current flowing through a wire with conductivity $\sigma = 3\times10^7\ s/m$ and the relative permeability $\varepsilon_r = 1$ is given by $I_c = 3\sin\varpi t(mA)$. If $\varpi = 10^8$ rad/sec, find the displacement current. (8)

(ii) An electric field in a medium which is source free is given by $E = 1.5\cos(10^8 t - \beta z)\bar{a}_x V/m$. Find B,H and D. Assume $\varepsilon_r = 1, \mu_r = 1, \sigma = 0$. (8)

15. (a) A plane sinusoidal electromagnetic wave traveling in space has $E_{max} = 150\,\mu V/m$. (16)

(i) Find the accompanying H_{max}.

(ii) Propagation is in X direction and H is oriented in Y direction. What is the direction of E?

(iii) Compute the average power transmitted.

Or

(b) Explain in detail on what happens when the wave is incident

(i) Normally on perfect conductor (8)

(ii) Obliquely to the surface of perfect dielectrics. (8)
